MID-IR SPECTRA OF HED METEORITES AND SYNTHETIC PYROXENES: RESTSTRAHLEN FEATURES (9–12 μm).

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In an earlier study, Hamilton (2000) [1] mapped the behavior of the 9–12 μm reststrahlen structures with composition in a suite of primarily natural terrestrial pyroxenes. Here we examine the same set of reststrahlen features in the spectra of diogenites and eucrites and place them in the context of the terrestrial samples and of a suite of well-characterized synthetic pyroxenes [2, 3]. The results will be useful to the interpretation of mid-IR spectra of 4 Vesta and other basaltic asteroids.

The 10- and 11- μm reststrahlen structures vary in shape and wavelength with pyroxene composition [1]. The 10 μm emissivity maximum is bounded by the minima designated "critical absorptions" CA1 and CA2 by Hamilton (2000) [1]. Although the systematic variation of the wavelengths of CA1 and CA2 minima with Fe content has been established, it is not always practical to establish the wavelengths of these minima in telescopic spectra of multi-mineral assemblages. The short-wavelength side of CA1 is governed by the Christiansen feature, which may be shifted in wavelength by non-pyroxene minerals in the rock (for example, olivine) or by pressure and temperature effects [4]. CA2 presents a different problem: CA2 and CA3 are only distinguishable at a relatively high S/N level. For these reasons, we have examined the wavelength of the 10 μm emissivity maximum, which also varies systematically with the Fe content of low-Ca pyroxenes.

In enstatites En_{83} and above, the 10-micron structure is divided by a local minimum at 9.9 microns (Fig. 3). Less magnesian orthopyroxenes (En_{35}–En_{80}) feature a single well-defined local maximum in this region. In the six available mid-IR laboratory spectra of diogenites, the wavelength of this feature falls within a narrow range between 9.856 and 9.893 microns irrespective of particle size.

In Figure 1, the 10-micron maximum wavelength is plotted against the "CA4" of [1] (11.4 μm emissivity minimum) position for various eucrites and diogenites. The ellipses around the diogenites and basaltic eucrites are 2σ from their means. For comparison, on the same figure, we have plotted the positions of these two features in the RELAB spectra of a collection of synthetic pyroxenes representing a range of compositions [2, 3] and ASU emissivity spectra of natural pyroxenes of near-diogenitic composition [1]. In general, low-Ca pyroxenes with more ferroan compositions have longer-wavelength 10 μm maxima and shorter-wavelength 11.4 μm minima, so that they appear toward
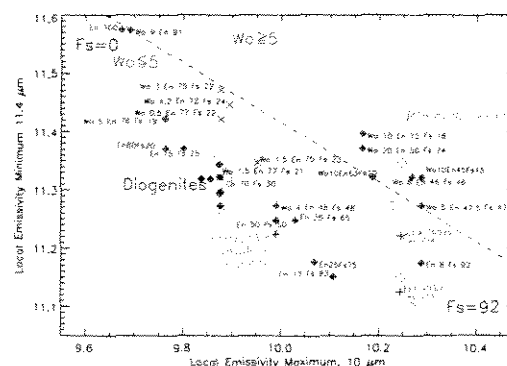

Figure 1: Wavelengths of the 11.4 μm minimum ("CA4" of [1]) vs. the 10 μm maximum in the emissivity spectra of diogenites (blue), basaltic eucrites (orange), two cumulate eucrites (green), and natural pyroxenes of diogenite-like composition (purple) from the ASU collection described by [1]. Also plotted are the same features as they appear in the inverted reflectance spectra of the synthetic pyroxenes (red) of Linsley and Turnock [RELAB; 2] and of HED meteorites (RELAB and Salisbury (1991) [5]). See also Fig. 2.
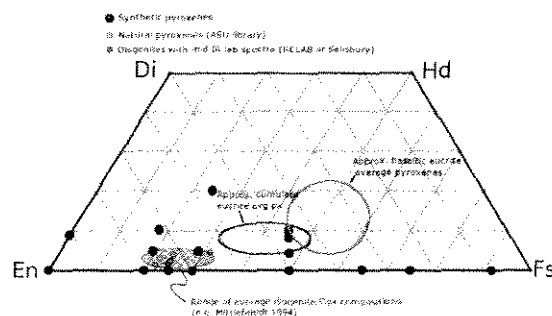

Figure 2: Pyroxene quadrilateral illustrating the compositions of diogenites and pyroxene samples plotted in Fig. 1.

the lower right of Fig. 1. Compositions are also plotted on the pyroxene quadrilateral in Fig. 2.

Eucritic pyroxenes (Fig. 6) are generally much more ferroan than diogenitic; consequently, the eucrites plot to the right of the diogenite range on Fig. 1. Unlike diogenites, eucrites also have substantial amounts of plagio-
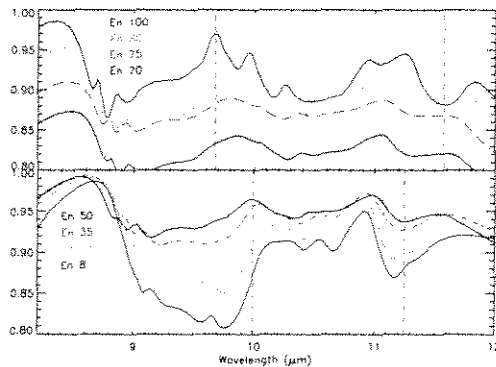
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Figure 3: Mid-IR spectra (RELAB) of synthetic Ca-free pyroxene samples. Vertical dashed lines indicate the positions of the "10-micron" maximum and "11.4-micron" minimum (CA4) in En 100 (top) and En 50 (bottom). Spectra in upper plot are offset by 0.04 for clarity.
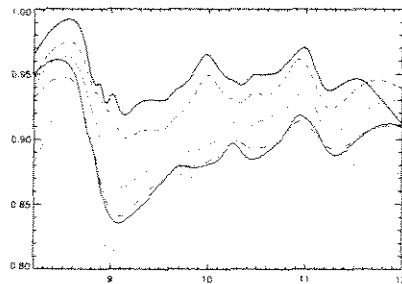

Figure 4: Mid-IR spectra (RELAB) of synthetic pyroxene samples, Mg/(Mg+Fe)=0.5. Top: $En_{50}Fs_{50}$. Bottom: $Wo_{20}En_{40}Fs_{40}$. Spectra are offset by 0.01 for clarity.

Figure 5: Mid-IR spectra of cumulate eucrite Y-980318 (RELAB) and its mineral separates. From top to bottom: whole-rock powder, "Fe-Px", "Ca-Px", and plagioclase. The positions of the 10 μm maximum and 11 μm minimum are identical in the whole-rock spectrum and pyroxene separates.

Figure 6: Mid-IR spectra of cumulate (top) and basaltic eucrites (RELAB). From top to bottom: ALH 85001, Y-980318, ALH 81001, PCA 82501, EET 92003, PCA 91006, PCA 82501, PCA 82502.

clase feldspar in addition to their pyroxenes. For the cumulate eucrite Y-980318, spectra of both the whole rock and mineral separates (plagioclase and two pyroxenes) have been made available in the RELAB database [6]. Notably, the low-Ca pyroxene separates and the whole-rock mid-IR spectra had identical wavelength positions for both the 10 μm maximum and the 11.4 μm minimum, indicating that these two spectral features remain sensitive to pyroxene composition at the plagioclase abundances found in cumulate eucrites. The dominant pyroxene in Y-980318 is $Wo_{2.0}En_{51.9}$ [7], consistent with the eucrite's position in Fig. 1 near the synthetic $En_{50}Fs_{50}$ sample.
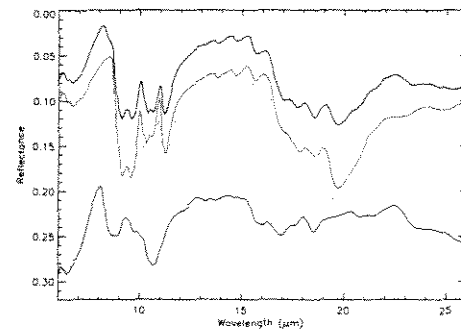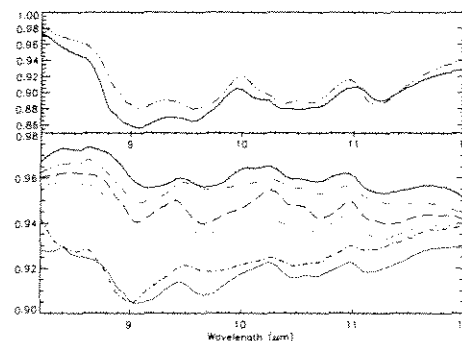
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